VERIFICATION OF A TRANSLATION

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Signature Makoto Yamazaki Date October 17, 2011

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SPECIFICATION

[TITLE OF THE INVENTION]

WIRELESS COMMUNICATION APPARATUS AND WIRELESS COMMUNICATION METHOD

[SCOPE OF CLAIMS FOR PATENT]

[Claim 1] A wireless communication apparatus comprising:

a reception quality measuring section that measures a reception quality of each of a plurality of sub-carriers within a communication band from a received signal;

a selecting section that selects a number of sub-carriers designated by a higher-level station apparatus in descending order of the measured reception quality, based on a measurement value indicating the reception quality measured by the reception quality measuring section;

a reception quality information generating section that generates reception quality information of each of the sub-carriers selected by the selecting section, based on the measurement value indicating the reception quality measured by the reception quality measuring section; and

a transmitting section that transmits the reception quality information generated by the reception quality information generating section.

[Claim 2] A wireless communication apparatus comprising:

a reception quality measuring section that measures a reception quality of each of a plurality of sub-carriers within a communication band from a received signal;

a reception quality information generating section that generates the reception quality information of each sub-carrier, based on a measurement value indicating the reception quality measured by the reception quality measuring section;

a selecting section that selects the reception quality information of a sub-carrier where the measurement value indicating the reception quality measured by the reception

quality measuring section is equal to or greater than a first threshold value designated by higher-level station apparatus; and

a transmitting section that transmits the reception quality information selected by the selecting section.

[Claim 3] The wireless communication apparatus according to claim 1 or according to claim 2, wherein:

the reception quality information generating section generates the reception quality information indicating a different reception quality according to whether the measurement value is less than a second threshold value or the measurement value is equal to or greater than the second threshold; and

the transmitting section transmits the reception quality information and identification information indicating the sub-carrier selected by the selecting section.

[Claim 4] The wireless communication apparatus according to claims 1 to 3, wherein:

the reception quality information generating section generates the reception quality information indicating a different reception quality according to whether the measurement value is less than a second threshold value or the measurement value is equal to or greater than the second threshold; and

the transmitting section transmits the reception quality information with a same sub-carrier as the sub-carrier generated by the reception quality information or a sub-carrier having a one-to-one correspondence with the generated sub-carrier.

[Claim 5] The wireless communication apparatus according to claim 4, further comprising a spreading section that spreads the reception quality information using a specific spreading code for each user,

wherein the transmitting section transmits the reception quality information spread by the spreading section.

[Claim 6] The wireless communication apparatus according to claims 1 and 2, wherein the transmitting section transmits identification information indicating the sub-carrier

selected by the selecting section as the reception quality information.

[Claim 7] The wireless communication apparatus according to claims 1 or according to claim 2, further comprising:

an error detection section that carries out error detection on the received signal;

a spreading code selecting section that has a reference table, which is in common with the higher-level station apparatus, storing spreading code selection information which provides a relationship between a spreading code and associating reception quality information for selection use indicating a different reception quality according to whether the measurement value is less than a second threshold value or the measurement value is equal to or greater than the second threshold value, and the spreading code selecting section that selects the spreading code with reference to the spreading code selection information using the reception quality information for selection use, acquired by comparing the measurement value to the second threshold value;

an alloacting section that allocates an error determination signal as the reception quality information indicating whether or not the error detection section detects an error, to the sub-carrier selected by the selecting section; and

a spreading section that spreads the error determination signal allocated to a sub-carrier by the allocating section, using the spreading code selected by the spreading code selecting section,

wherein the transmitting section transmits the error determination signal spread by the spreading seciton.

[Claim 8] A communication terminal apparatus comprising one of wireless communication apparatuses according to claims 1 to 7.

[Claim 9] A base station apparatus that performs communication with the wireless communication apparatus according to claim 1 or according to claim 2, comprising:

a modulating section that modulates packet data using an M-ary number adaptively selected based on the reception quality information included in the received signal;

an encoding section that encodes the packet data using an encoding rate adaptively selected based on the reception quality information included in the received signal; and

a scheduling section that identifies a sub-carrier selected by each wireless communication apparatus in the sub-carrier within the communication band, based on the reception quality information included in the received signal, and allocates packet data of a higher M-ary number or a higher encoding rate to the identified sub-carrier having superior reception quality.

[Claim 10] A base station apparatus that performs communicaiton with the wireless communication apparatus according to claim 7, the base station apparatus further comprising:

a de-spreading section that de-spreads the received signal in order using a specific spreading code for each wireless communication apparatus and for each sub-carrier, and obtains a de-spreading output for said each wireless communication apparatus and for said each sub-carrier;

a determining section that has the reference table storing the spreading code selection information, selects the sub-carrier where the de-spreading output is equal to or greater than a third threshold value, and determines a reception quality per sub-carrier in said each wireless communication apparatus with reference to the spreading code selection information, using the sperading code per selected sub-carrier in said each wireless communication apparatus;

a modulating section that modulates packet data using an M-ary number adaptively selected based on the determined reception quality per sub-carrier in said each wireless communication apparatus in the determining section;

an encoding section that performs coding using an encoding rate adaptively selected based on the reception quality per sub-carrier in said each wireless communication apparatus determined by the determining section; and

a scheduling section that identifies a sub-carrier selected by said each wireless

communication apparatus in a sub-carrier within a communication band, based on the reception quality per sub-carrier in said each wireless communication apparatus determined by the determining section, and allocates packet data of a higher M-ary number or a higher encoding rate to the identified sub-carrier having superior reception quality.

[Claim 11] A reception quality reporting method comprising:

measuring step of measuring reception quality of a plurality of sub-carriers within a communication band from a received signal on a per sub-carrier basis;

a selection step of selecting a number of sub-carriers designated by higher-level station apparatus in descending order of measured reception quality, based on a measurement value indicating the measured reception quality;

a generating step of generating reception quality information of the subcarriers selected by the selecting section on a per sub-carrier basis, based on the measurement value indicating the measured reception quality; and

a transmitting step of transmitting the generated reception quality information.

[Claim 12] A reception quality reporting method comprising the steps of:

measuring a reception quality of each of a plurality of sub-carriers within a communication band from a received signal; generating the reception quality information of each sub-carrier, based on a measurement value indicating the measured reception quality;

selecting the reception quality information of a sub-carrier where the measurement value indicating the measured reception quality is equal to or greater than a first threshold value designated by high--level station apparatus; and

transmitting the selected reception quality information.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical Field]

The present invention relates to a wireless communication and reception quality reporting method, and particularly relates to a wireless communication apparatus and reception quality reporting method for performing high-speed packet communication using adaptive modulation and scheduling.

[0002]

[Prior Art]

In a conventional art, in HSDPA (High-Speed Downlink Packet Access) of 3GPP, adaptive modulation where the modulation scheme is adaptively controlled according to propagation path conditions and scheduling for transmitting a user signal for which propagation path conditions are comparatively superior have been employed in downlink high-speed packet transmission. In multi-carrier transmission such as OFDM and MC-CDMA being examined as transmission schemes for beyond 3G mobile communication systems, high speed transmission is implemented using a large number of sub-carriers. In this kind of transmission scheme, performing adaptive modulation and scheduling every sub-carrier is examined.

With this kind of adaptive modulation and scheduling system, it is necessary for the mobile station to give reporting of channel quality information (CQI (Channel Quality Indicator)) of each sub-carrier instantaneously at a base station.

[0003]

The mobile station reports individual CQI's on every sub-carrier for all sub-carriers to the base station. A base station then determines the sub-carrier, modulation scheme and encoding rate to be used at each mobile station in accordance with a predetermined scheduling algorithm taking into consideration the CQI's from each mobile station. Typically, sub-carriers with comparatively good propagation path conditions are allocated to each mobile station, and a modulation scheme and encoding rate satisfying a predetermined packet error rate are employed for these propagation conditions. In the event that a base station transmits to a plurality of mobile stations at the same time,

frequency scheduling is carried out using CQI's of all of the sub-carrier from all of the users. In other words, if there are 64 sub-carriers, it is necessary for each mobile station to give reporting of 64 CQI's. In this event, when a CQI is expressed using five bits, it is necessary to transmit a total of 64 x 5 = 320 bits per one user in each wireless frame.

Non-Patent Document 1: Hara, Kawabata, Duan and Sekiguchi, "MC-CDM System for Packet Communications Using Frequency Scheduling," TECHNICAL REPORT OF IEICE, RCS2002-129, July 2002, refer to pp. 61-66

[0004]

[Disclosure of Invention]

[Problems to be Solved by the Invention]

However, with wireless communication apparatus of the conventional art, the quantity of signal required for CQI reporting is enormous. This means that interference incurred by other data channels and other cells is large, and the quantity of data that can be transmitted is therefore substantially reduced.

Further, as the quantity of signal for giving CQI reporting is enormous, power consumption of the mobile station is increased and a battery life is shortened.

[0005]

In view of the above-noted point, it is an object of the present invention to provide a wireless communication apparatus and reception quality reporting method capable of increasing the data capacity that can be transmitted and reducing power consumption by reducing the amount of control signal transmitted, and increasing system capacity by reducing interference with respect to other wireless communication apparatuses.

[0006]

[Means for Solving the Problem]

The wireless communication apparatus of the present invention employs a configuration having: a reception quality measuring section that measures a reception

quality of each of a plurality of sub-carriers within a communication band from a received signal; a selecting section that selects a number of sub-carriers designated by a higher-level station apparatus in descending order of the measured reception quality, based on a measurement value indicating the reception quality measured by the reception quality measuring section; a reception quality information generating section that generates reception quality information of each of the sub-carriers selected by the selecting section, based on the measurement value indicating the reception quality measured by the reception quality measuring section; and a transmitting section that transmits the reception quality information generated by the reception quality information generating section.

[0007]

With this configuration, the number of sub-carriers having good reception quality and designated by higher-level station apparatus, is selected from all subcarriers within a communication band, and reception quality information of the selected sub-carrier is generated and transmitted, so that it is possible to reduce the amount of control signal transmitted. By this means, it is possible to increase the data capacity that can be transmitted and reduce power consumption. Further, interference with respect to other wireless communication apparatus can be reduced, so that it is possible to increase the system capacity.

[0008]

The wireless communication apparatus of the present invention employs a configuration having: a reception quality measuring section that measures a reception quality of each of a plurality of sub-carriers within a communication band from a received signal; a reception quality information generating section that generates the reception quality information of each sub-carrier, based on a measurement value indicating the reception quality measured by the reception quality measuring section; a selecting section that selects the reception quality information of a sub-carrier where the measurement value indicating the reception quality measured by the reception quality measuring section is

equal to or greater than a first threshold value designated by higher-level station apparatus; and a transmitting section that transmits the reception quality information selected by the selecting section.

[0009]

With this configuration, a sub-carrier having reception quality equal to or greater than a threshold value designated by higher-level station apparatus, is selected from all subcarriers within a communication band, and reception quality information of the selected sub-carrier is transmitted, so that it is possible to reduce the amount of control signal transmitted. By this means, it is possible to increase the data capacity that can be transmitted and reduce power consumption. Further, interference with respect to other wireless communication apparatus can be reduced, so that it is possible to increase the system capacity.

[0010]

The wireless communication apparatus of the present invention employs a configuration where the reception quality information generating section generates the reception quality information indicating a different reception quality according to whether the measurement value is less than a second threshold value or the measurement value is equal to or greater than the second threshold and where the transmitting section transmits the reception quality information and identification information indicating the sub-carrier selected by the selecting section, in addition to the above-described configuration.

[0011]

With this configuration, in addition to the above-noted effect, identification information is transmitted to identify the selected sub-carrier, so that it is possible to recognize a sub-carrier having good reception quality in a simple manner of referring to the identification information in the receiving side.

[0012]

The wireless communication apparatus of the present invention employs a

configuration where the reception quality information generating section generates the reception quality information indicating a different reception quality according to whether the measurement value is less than a second threshold value or the measurement value is equal to or greater than the second threshold; and where the transmitting section transmits the reception quality information with a same sub-carrier as the sub-carrier generated by the reception quality information or a sub-carrier having a one-to-one correspondence with the generated sub-carrier, in addition to the above-described configuration.

[0013]

With this configuration, in addition to the above-noted effect, the CQI is allocated to the sub-carrier that has generated the CQI or the sub-carrier having a one-to-one correspondence with the generated sub-carrier, so that a base station apparatus can determine in which sub-carrier the CQI is generated without transmitting SC number information.

[0014]

The wireless communication apparatus of the present invention employs a configuration having a spreading section that spreads the reception quality information using a specific spreading code for each user, and where the transmitting section transmits the reception quality information spread by the spreading section, in addition to the above-described configuration.

[0015]

With this configuration, in addition to the above-noted effect, a sub-carrier to which measurement value information is allocated is spread using a specific spreading code for each user and is transmitted, so that it is possible to determine which user's wireless communication apparatus transmits the measurement value information, and, even if a plurality of users transmit the same measurement value information of a sub-carrier, relatively distinguish the reception quality of each user and perform scheduling reliably.

[0016]

The wireless communication apparatus of the present invention employs a configuration where the transmitting section transmits identification information indicating the sub-carrier selected by the selecting section, in addition to the above-described configuration as the reception quality information.

[0017]

With this configuration, in addition to the above-noted effect, only identification information to identify a selected sub-carrier having good reception quality is transmitted, and packet data is modulated by a modulation scheme fixed in the receiving side and is encoded by a fixed encoding rate, so that it is possible to significantly reduce the amount of signal transmitted upon transmitting reception quality information and simplify processing of transmitting side and receiving side in the receiving side that receives reception quality information without complex processing.

[0018]

The wireless communication apparatus of the present invention employs a configuration having: an error detection section that carries out error detection on the received signal; a spreading code selecting section that has a reference table, which is common with the higher-level station apparatus, storing spreading code selection information which provides a relationship between a spreading code and associating reception quality information for selection use indicating a different reception quality according to whether the measurement value is less than a second threshold value or the measurement value is equal to or greater than the second threshold value, and the spreading code selecting section that selects the spreading code with reference to the spreading code selection information using the reception quality information for selection use, acquired by comparing the measurement value to the second threshold value; an alloacting section that allocates an error determination signal as the reception quality information indicating whether or not the error detection section detects an error, to the sub-carrier selected by the selecting section; and a spreading section that spreads the error determination signal

allocated to a sub-carrier by the allocating section, using the spreading code selected by the spreading code selecting section, and where the transmitting section transmits the error determination signal spread by the spreading seciton, in addition to the above-described configuration.

[0019]

With this configuration, in addition to the above-noted effect, error determination signal such as an ACK signal or NACK signal for one bit can be made reception quality information, and a signal to report whether or not to need retransmission and the reception quality information can be shared without transmitting a dedicated signal for the reception quality information, so that it is possible to reduce the amount of signal transmitted upon transmitting the reception quality information without increasing the amount of signal transmitted.

[0020]

The wireless communication apparatus of the present invention employs a configuration having one of wireless communication apparatuses described above.

[0021]

With this configuration, part of the sub-carrier designated by higher-level station apparatus is selected from all sub-carriers within a communication band and only reception quality information of the selected part of the sub-carrier is transmitted, so that it is possible to increase data capacity that can be transmitted and reduce power consumption by reducing the amount of signals transmitted through the uplink. Further, interference with respect to other wireless communication apparatuses and base station apparatuses can be reduced, so that it is possible to increase system capacity.

[0022]

The wireless communication apparatus of the present invention that performs communication with the wireless communication apparatus described above, employs a configuration having: a modulating section that modulates packet data using an M-ary

number adaptively selected based on the reception quality information included in the received signal; an encoding section that encodes the packet data using an encoding rate adaptively selected based on the reception quality information included in the received signal; and a scheduling section that identifies a sub-carrier selected by each wireless communication apparatus in the sub-carrier within the communication band, based on the reception quality information included in the received signal, and allocates packet data of a higher M-ary number or a higher encoding rate to the identified sub-carrier having superior reception quality.

[0023]

With this configuration, part of the sub-carrier allocated by higher-level station apparatus is selected from all sub-carriers within a communication band and only reception quality information of the selected part of the sub-carrier is transmitted, so that it is possible to increase data capacity that can be transmitted and reduce power consumption by reducing the amount of signals transmitted. Further, interference with respect to other wireless communication apparatuses can be reduced, so that it is possible to increase system capacity. Further, it is possible to allocate optimum packet data based on the reception quality of the sub-carrier to the sub-carrier and perform high-speed communication efficiently.

[0024]

The wireless communication apparatus of the present invention that performs communication with the wireless communication apparatus described above, employs a configuration having: a de-spreading section that de-spreads the received signal in order using a specific spreading code for each wireless communication apparatus and for each sub-carrier, and obtains a de-spreading output for said each wireless communication apparatus and for said each sub-carrier; a determining section that has the reference table storing the spreading code selection information, selects the sub-carrier where the de-spreading output is equal to or greater than a third threshold value, and determines a

reception quality per sub-carrier in said each wireless communication apparatus with reference to the spreading code selection information, using the sperading code per selected sub-carrier in said each wireless communication apparatus; a modulating section that modulates packet data using an M-ary number adaptively selected based on the determined reception quality per sub-carrier in said each wireless communication apparatus in the determining section; an encoding section that performs coding using an encoding rate adaptively selected based on the reception quality per sub-carrier in said each wireless communication apparatus determined by the determining section; and a scheduling section that identifies a sub-carrier selected by said each wireless communication apparatus in a sub-carrier within a communication band, based on the reception quality per sub-carrier in said each wireless communication apparatus determined by the determining section, and allocates packet data of a higher M-ary number or a higher encoding rate to the identified sub-carrier having superior reception quality.

[0025]

With this configuration, part of the sub-carrier allocated by higher-level station apparatus is selected from all sub-carriers within a communication band and only reception quality information of the selected part of the sub-carrier is transmitted, so that it is possible to increase data capacity that can be transmitted and reduce power consumption by reducing the amount of signals transmitted. Further, interference with respect to other wireless communication apparatuses can be reduced, so that it is possible to increase system capacity. Further, it is possible to distinguish a sub-carrier having good reception quality in a simple manner of de-spreading processing.

[0026]

The reception quality reporting method of the present invention includes the steps of: measuring step of measuring reception quality of a plurality of sub-carriers within a communication band from a received signal on a per sub-carrier basis; a selection step of selecting a number of sub-carriers designated by higher-level station apparatus in

descending order of measured reception quality, based on a measurement value indicating the measured reception quality; a generating step of generating reception quality information of the subcarriers selected by the selecting section on a per sub-carrier basis, based on the measurement value indicating the measured reception quality; and a transmitting step of transmitting the generated reception quality information.

[0027]

With this configuration, the number of sub-carriers having good reception quality and designated by higher-level station apparatus, is selected from all subcarriers within a communication band, and reception quality information of the selected sub-carrier is generated and transmitted, so that it is possible to increase data capacity and reduce power consumption by reducing the amount of control signal transmitted. Further, interference with respect to other wireless communication apparatuses can be reduced, so that it is possible to increase system capacity.

[0028]

The reception quality reporting method of the present invention includes the steps of: measuring a reception quality of each of a plurality of sub-carriers within a communication band from a received signal; generating the reception quality information of each sub-carrier, based on a measurement value indicating the measured reception quality; selecting the reception quality information of a sub-carrier where the measurement value indicating the measured reception quality is equal to or greater than a first threshold value designated by high--level station apparatus; and transmitting the selected reception quality information.

[0029]

With this method, a sub-carrier having reception quality equal to or greater than a threshold value designated by higher-level station apparatus, is selected from all subcarriers within a communication band, and reception quality information of the selected sub-carrier is transmitted, so that it is possible to increase data capacity that can be transmitted and

reduce power consumption by reducing the amount of control signal transmitted. Further, interference with respect to other wireless communication apparatuses can be reduced, so that it is possible to increase system capacity.

[0030]

[Effect of the Invention]

As described above, according to the present invention, by reducing the amount of signal transmitted, it is possible to increase the data capacity that can be transmitted and reduce power consumption and, by reducing interference with respect to other wireless communication apparatuses, it is possible to increase system capacity.

[0031]

[Embodiments of the Invention]

A gist of the present invention is to select part of the sub-carrier allocated by higher-level station apparatus from all sub-carriers within a communication band and generate and transmit only reception quality information (CQI) of the selected part of the sub-carrier, by measuring reception quality per sub-carrier and selecting selects the number of sub-carriers designated by a control station apparatus in order of good reception quality. Further, another gist of the present invention is to measure reception quality and generate reception quality information on a per sub-carrier basis, select a sub-carrier having reception quality equal to or greater than a threshold value designated by a control station apparatus and transmit reception quality information of the selected sub-carrier.

[0032]

(Embodiment 1)

FIG.1 is a block diagram showing a configuration of wireless communication apparatus 100 of Embodiment 1 of the present invention.

[0033]

Reception wireless processing section 102 down converts and suchlike a received signal received at antenna 101 from a radio frequency to a baseband frequency and outputs

to guard interval (hereinafter referred to as "GI") removing section 103.

[0034]

GI removing section 103 removes GI's from a received signal inputted from reception wireless processing section 102 and then outputs to fast Fourier transform (hereinafter referred to as "FFT; Fast Fourier Transform") section 104.

[0035]

After converting the received signal inputted from GI removing section 103 from a serial data format to a parallel data format, FFT section 104 subjects the received signal to FFT and outputs to control information extraction section 105, user data extraction section 108 and pilot signal extraction section 112.

[0036]

Control information extraction section 105 extracts control information contained in CQI quantity information transmitted from the base station apparatus from the received signal inputted from FFT section 104 and outputs to demodulating section 106.

[0037]

Demodulating section 106 subjects control information inputted by control information extraction section 105 to demodulation processing and outputs to a decoding section 107.

[0038]

Decoding section 107 decodes demodulated control information inputted by demodulating section 106, outputs decoded control information, and outputs CQI quantity information contained in the control information to sub-carrier selecting section (hereinafter referred to as "SC selecting section) 127.

[0039]

User data extraction section 108 extracts user data from the received signal inputted by FFT section 104 and outputs to demodulating section 109.

[0040]

Demodulating section 109 subjects user data inputted by user data extraction section 108 to demodulation processing and outputs to reception HARQ (Hybrid Automation Repeat Request) section 110.

[0041]

If user data inputted by demodulating section 109 is new data, reception HARQ section 110 saves all or part of the user data and outputs the user data to a decoding section 111. If the user data inputted by demodulating section 109 is re-transmitted data, reception HARQ section 110 combines the saved user data with the re-transmitted data, saves the combined use data, and outputs the combined user data to decoding section 111.

[0042]

Decoding section 111 decodes user data inputted by reception HARQ section 110 and outputs user data.

Further, decoding section 111 performs error detection and decoding, and outputs the result to ACK/NACK generating section 119. The error detection may use CRC (Cyclic Redundancy Checks). This error detection is not limited to CRC and arbitrary error detection methods may also be applied.

[0043]

Pilot signal extraction section 112 extracts a pilot signal from the received signal inputted by FFT section 104 and outputs to reception quality measuring sections 113-1 to 113-n.

[0044]

Reception quality measuring sections 113-1 to 113-n are provided for the useable number of sub-carriers. Reception quality measuring sections 113-1 to 113-n measures reception quality every sub-carrier for all of the sub-carriers using a pilot signal inputted from pilot signal extraction section 112. Measurement value information indicating reception quality every measured sub-carrier is outputted to CQI generation section 114 and SC selecting section 127. Arbitrary measurement values such as CIR (Carrier to

Interference Ratio), SIR (Signal to Interference Ratio) and suchlike measured every sub-carrier can be used for the measurement value information.

[0045]

CQI generating section 114 constituting a reception quality information generating section compares reception quality information inputted by reception quality measuring section 113 with a plurality of threshold values (second threshold values) for CQI selection use set according to reception quality, for a sub-carriers of a sub-carrier number (hereinafter referred to as "SC number") information that is identification information inputted from SC selecting section 127, and selects and generates a CQI every sub-carrier. In other words, CQI generating section 114 has a reference table that stores information for CQI selection use to which different CQI's are allocated every predetermined region for measurement values indicating reception quality separated by threshold values for use in selection of the plurality of CQI's, and selects CQI's by referring to information for CQI selection use employing reception quality information inputted by reception quality measuring section 113. CQI generating section 114 generates one CQI for one sub-carrier and therefore generates CQI's for the designated number of sub-carriers. CQI generating section 114 outputs the generated CQI's to an encoding section 115. Generation of a CQI is not limited to after selection of a sub-carrier and it is also possible to select a generated CQI based on CQI quantity information after generating CQI's for all of the sub-carriers.

[0046]

Encoding section 115 encodes CQI's for the number of designated sub-carriers inputted by CQI generating section 114 and outputs to modulating section 116.

[0047]

Modulating section 116 modulates CQI's inputted by encoding section 115 and outputs to multiplexer 122.

[0048]

Encoding section 117 encodes SC number information inputted by SC selecting

section 127 and outputs to modulating section 118.

[0049]

Modulating section 118 modulates SC number information inputted by encoding section 117 and outputs to multiplexer 122.

[0050]

ACK/NACK generating section 119, according to error detection result information inputted by decoding section 111, generates a NACK signal constituting an error determination signal if re-transmission is necessary, generates an ACK signal constituting an error determination signal in the event that re-transmission is not necessary, and outputs the generated NACK signal and ACK signal to an encoding section 120.

[0051]

Encoding section 120 encodes a NACK signal or ACK signal inputted by ACK/NACK generating section 119 and outputs to modulating section 121.

[0052]

Modulating section 121 modulates a NACK signal or ACK signal inputted by encoding section 120 and outputs to multiplexer 122.

[0053]

Multiplexer 122 multiplexes CQI's inputted by modulating section 116, SC number information inputted by modulating section 118, and NACK signals or ACK signals inputted by modulating section 121 so as to generate transmission data and outputs the generated transmission data to a serial/parallel (hereinafter referred to as "S/P") converter 123.

[0054]

S/P converter 123 converts transmission data inputted by multiplexer 122 from a serial data format to a parallel data format and outputs to inverse fast Fourier transform (hereinafter referred to as "IFFT: Inverse Fast Fourier Transform") section 124.

[0055]

IFFT section 124 subjects transmission data inputted by S/P converter 123 to inverse fast Fourier transformation and outputs to GI insertion section 125.

[0056]

GI insertion section 125 inserts GI's into transmission data inputted from IFFT section 124 and outputs to a transmission wireless processing section 126.

[0057]

Transmission wireless processing section 126 upconverts transmission data inputted from GI insertion section 125 from a baseband frequency to a radio frequency and transmits from antenna 101.

[0058]

SC selecting section 127 constituting a selecting section selects a number of sub-carriers designated by the CQI quantity information in descending order of reception quality using CQI quantity information inputted by decoding section 107 and reception quality information inputted by reception quality measuring sections 113-1 to 113-n. SC selecting section 127 then outputs the selected sub-carriers as SC number information to CQI generating section 114 and encoding section 117. In this way, SC selecting section 127 selects the number of sub-carriers designated by control station apparatus. Not only in the event that the sub-carriers are selected in descending order of reception quality, SC selecting section 127 may also set a predetermined threshold value and select a number of arbitrary sub-carriers designated by the CQI quantity information from sub-carriers of reception quality of the threshold value or higher.

[0059]

Next, a configuration for a base station apparatus as a higher-level station apparatus of wireless communication apparatus 100 is described using FIG.2. FIG.2 is a block diagram showing a configuration of base station apparatus 200.

[0060]

Control information extraction section 205, demodulating section 206, decoding

section 207, encoding section 209, transmission HARQ section 210, modulating section 211, encoding section 212 and demodulating section 213 constitute transmission data processing sections 221-1 to 221-n. Transmission data processing sections 221-1 to 221-n are provided for the number of users and each of the transmission data processing sections 221-1 to 221-n carries out processing on transmission data for transmission to one user. Further, encoding section 212 and modulating section 213 constitute control data transmission processing section 220.

[0061]

Reception wireless processing section 202 down converts a signal received at antenna 201 from a radio frequency to a baseband frequency and suchlike and outputs to GI removal section 203.

[0062]

GI removal section 203 removes GI from the received signal inputted by reception wireless processing section 202 and outputs to FFT section 204.

[0063]

After a received signal inputted by GI removal section 203 is converted from serial data format to parallel data format, FFT section 204 separates the received signal for each user and outputs to respective control information extraction section 205.

[0064]

Control information extraction section 205 then extracts control information from the received signal inputted by FFT section 204 and outputs to demodulating section 206.

[0065]

Demodulating section 206 then demodulates control information inputted by control information extraction section 205 and outputs to decoding section 207.

[0066]

Decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs CQI's for each of the designated number of sub-carriers included in the

received signal to control section 208. Further, decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs SC number information included in the received signal to control section 208. Moreover, decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs a NACK signal or ACK signal included in the received signal to transmission HARQ section 210.

[0067]

Control section 208 as a scheduling section carries out scheduling based on a scheduling algorithm using CQI's and SC number information for wireless communication apparatus 100 of each user inputted by decoding section 207, and adaptively selects MCS (Modulation Coding Schemes) for the M-ary numbers and encoding rates and suchlike. In other words, control section 208 is capable of determining reception quality every sub-carrier of each wireless communication apparatus 100 using the CQI's and SC number information for each sub-carrier transmitted from the wireless communication apparatus 100 for each user. The MCS is then selected according to reception quality for each sub-carrier of each wireless communication apparatus 100. Control section 208 has knowledge of the number of sub-carriers and it is possible to use and allocates transmission data to be sent to each wireless communication apparatus 100 within the range of usable sub-carriers to each sub-carrier. At this time, control section 208 carries out allocation, determining reception quality of a sub-carrier for which CQI's has not been transmitted by wireless communication apparatus 100 as being the poorest. Control section 208 outputs encoding rate information selected for each sub-carrier to encoding section 209, outputs modulation scheme information selected for each sub-carrier to modulating section 211 and outputs sub-carrier information allocated to each wireless communication apparatus 100 using scheduling to a sub-carrier allocation section 215.

[0068]

Encoding section 209 encodes inputted transmission data based on encoding rate information inputted by control section 208, and outputs to transmission HARQ section

210.

[0069]

Transmission HARQ section 210 outputs transmission data inputted by encoding section 209 to modulating section 211 and temporarily holds transmission data outputted to modulating section 211. In the event that an NACK signal is inputted by decoding section 207, a re-transmission is requested by wireless communication apparatus 100, and therefore transmission HARQ section 210 outputs temporarily held transmission data for which output is complete to modulating section 211 again. On the other hand, in the event that an ACK signal is inputted by demodulating section 207, transmission HARQ section 210 outputs new transmission data to modulating section 211.

[0070]

Modulating section 211 modulates transmission data inputted by transmission HARQ section 210 based on modulation scheme information inputted by control section 208 and outputs to multiplexer 214.

[0071]

Encoding section 212 then encodes control data and CQI quantity information inputted by a control station apparatus (not shown) as a higher-level station apparatus of base station apparatus 200, and outputs to modulating section 213.

The CQI quantity information is not limited to being inputted by the control station apparatus and may also be set by base station apparatus 200. Further, the CQI quantity information can also be set taking into consideration number of users and volume of traffic. Moreover, this may be set as a value corresponding to reception capability of every mobile station.

[0072]

Modulating section 213 modulates control data and CQI quantity information inputted by encoding section 212 and outputs to multiplexer 214.

[0073]

Multiplexer 214 multiplexes transmission data inputted by modulating section 211 and control data and CQI quantity information inputted by modulating section 213 for data to be transmitted to wireless transmission apparatus 100 of each user and outputs to sub-carrier allocation section 215. CQI quantity information is information specific to the wireless communication apparatus 100 of each user.

[0074]

Sub-carrier allocation section 215 rearranges multiplexed signals inputted by multiplexer 214 based on sub-carrier information for each wireless communication apparatus 100 inputted by control section 208 and outputs to S/P converter 216.

[0075]

S/P converter 216 converts transmission data inputted by sub-carrier allocation section 215 from serial data format to parallel data format and outputs to IFFT section 217.

[0076]

IFFT section 217 subjects transmission data inputted by S/P converter 216 to IFFT and outputs to GI insertion section 218. Transmission data transmitted to each of wireless communication apparatus 100 subjected to IFFT at IFFT section 217 is then allocated to frequency-scheduled sub-carriers at control section 208.

[0077]

GI insertion section 218 inserts GI's into transmission data inputted from IFFT section 217 and outputs to a transmission wireless processing section 219.

[0078]

Transmission wireless processing section 219 up converts etc. transmission data inputted from GI insertion section 218 from a baseband frequency to a radio frequency and transmits from antenna 201.

[0079]

Next, a description is given of a method for selecting sub-carriers at wireless communication apparatus 100 and format for transmission signals during transmission of

the CQI's of the selected sub-carriers using FIGs.3 to FIG.5.

[0080]

FIG.3 is a diagram showing sixty-four sub-carriers allocated within a range of a predetermined communication bandwidth F1. Base station apparatus 200 sends high-speed packet data to the wireless communication apparatus 100 of all the users using the sub-carriers 1 to 64. In the event that the reception quality of sub-carriers 11 to 21 and sub-carriers 34 to 41 is good from the reception quality measurement results at reception quality measuring sections 113-1 to 113-n, SC selecting section 127 selects sub-carriers 11 to 21 and sub-carriers 34 to 41. CQI generating section 114 generates CQI's for only sub-carriers 11 to 21 and sub-carriers 34 to 41, and generates SC number information for sub-carriers 11 to 21 and sub-carriers 34 to 41. On the other hand, CQI generating section 114 does not generate CQI's and SC number information for sub-carriers other than sub-carrier 11 to 21 and sub-carrier 34 to 41.

[0081]

FIG.4 is a diagram showing a format for a signal transmitted from wireless communication apparatus 100 to base station apparatus 200. Items of six-bit SC number information and five-bit CQI's are then paired together to constitute one item of sub-carrier control information. As shown in FIG.4, control information outputted by multiplexer 122 is a signal resulting from time-division-multiplexing of a pair of control information items for each sub-carrier for which CQI's are generated at CQI generating section 114 and a one-bit ACK/NACK signal.

[0082]

FIG.5 is a diagram showing a further example of a format for a signal transmitted from wireless communication apparatus 100 to base station apparatus 200. One item of sub-carrier control information is constituted by one bit of SC number information and five bits of CQI. As shown in FIG.5, control information outputted by multiplexer 122 is a signal resulting from time-division-multiplexing of SC number information of 64 bits from

the top for 64 sub-carriers, CQI's for only the sub-carriers for which CQI's are generated at CQI generating section 114, and one bit of ACK/NACK signal. The SC number information is information time-division-multiplexed in order from the first sub-carrier of the 64 sub-carriers, with SC number information for sub-carriers for which CQI's are generated being indicated as "1", and SC number information for sub-carriers for which CQI's are not generated as "0". Therefore, bit 1, bits 2 to 10, bits 22 to 33 and bits 42 to 64 are indicated as "0", and bits 11 to 21 and bits 34 to 41 are indicated as "1".

[0083]

At base station apparatus 200 receiving the CQI's and SC number information, control section 208 carries out scheduling of each sub-carrier for each wireless communication apparatus 100 by prioritizing allocation of sub-carriers 11 to 21 and sub-carriers 34 to 41. Further, it can also be considered to map data (for example, control data of high importance or playback data etc.) for which it is necessary to make the number of errors small with respect to the sub-carriers.

[0084]

According to this Embodiment 1, a number of sub-carriers for which reception quality is good designated by a base station apparatus are selected and CQI's are generated and transmitted for the selected sub-carriers. Therefore, it is possible to increase the data capacity that can be transmitted and reduce power consumption by reducing the signal volume transmitted through the uplink and also possible to increase system capacity by reducing interference with respect to other wireless communication apparatuses. Also, according to Embodiment 1, CQI's are generated only for selected sub-carriers and processing time while generating CQI's can therefore be made short. Further, according to Embodiment 1, designation while selecting sub-carriers for which CQI's are generated may be achieved simply by transmitting designation information designating the number of CQI's from the base station apparatus. It is therefore possible to reduce the amount of signal transmitted through the uplink without increasing the amount of signal transmitted through

the downlink.

[0085]

(Embodiment 2)

FIG.6 is a block diagram showing a configuration for a wireless communication apparatus 600 according to Embodiment 2 of the present invention.

[0086]

As shown in FIG.6, wireless communication apparatus 600 according to Embodiment 2 is of a configuration where SC selecting section 127 is omitted and a threshold value determining section 601 is added in wireless communication apparatus 100 of Embodiment 1 shown in FIG.1. In FIG.6, portions with the same configuration as for FIG.1 are given the same numerals and are not described.

Further, the configuration of the base station apparatus with the exception of sending CQI threshold value information instead of CQI quantity information is the same as the configuration of FIG.2 and is therefore not described.

[0087]

Decoding section 107 decodes demodulated control information inputted by demodulating section 106 and outputs control information, and outputs CQI threshold value information contained in the control information to a threshold value determining section 601.

[0088]

CQI generating section 114 generates CQI's for each sub-carrier for all of the sub-carriers using reception quality information inputted by reception quality measuring section 113. In other words, CQI generating section 114 has a reference table that stores information for CQI selection use to which different CQI's are allocated every predetermined region for measurement values indicating reception quality separated by threshold values for use in selection of the plurality of CQI's, and selects CQI's by referring to information for CQI selection use employing reception quality information inputted by

reception quality measuring section 113. CQI generating section 114 outputs the generated CQI's to threshold value determining section 601. The CQI generating section is not limited to the case of generating CQI's for all sub-carriers, and CQI's may be generated after sub-carriers are selected by determining threshold values for reception quality for each sub-carrier.

[0089]

Threshold value determining section 601 as a selecting section selects only CQI's for which the reception quality is greater than or equal to a threshold value using CQI's, which are inputted by CQI generating section 114, and CQI threshold value information, which is a first threshold value inputted by decoding section 107, outputs the selected CQI's to encoding section 115, and outputs SC number information for the selected CQI's to encoding section 117. Specifically, in the case of using CQI for eight levels of level 1 to 8, only CQI's of level 5 or greater are selected when a threshold value is level 5 or more, and only CQI's of level 4 or greater are selected when a threshold value is level 4 or more,. Threshold value determining section 601 is capable of adopting a method of outputting information for eight levels indicating which level of eight levels, level 1 to level 8, a selected CQI is at, or a method of outputting information of a relative value where, in the event that, for example, a threshold value is level 5 or more and a generated CQI is level 7, a value 2 that is a relative value with respect to the threshold value is outputted. In the case of adopting the method of outputting information for eight levels, three bits are required in order to express levels 1 to 8. In the case of adopting a method of outputting relative value information, if a difference in threshold value is 0 to 3, then only two bits of information are sufficient. The amount of signals transmitted can therefore be reduced in the case of transmitting relative value information. In the case of adopting the method of outputting relative value information, the base station stores threshold value information which is in common with wireless communication apparatus 600. The method for selecting CQI's at wireless communication apparatus 600 and format for transmitting

signals during transmission of the selected CQI's is the same as for FIG.3 to FIG.5 and is therefore not described.

[0090]

According to Embodiment 2, sub-carriers satisfying reception quality of a threshold value or more designated by the base station apparatus are selected and CQI's are generated and transmitted for the selected sub-carriers. By reducing the signal volume transmitted through the uplink, it is possible to increase the data capacity that can be transmitted and reduce power consumption and by reducing interference with respect to other wireless communication apparatuses, it is possible to increase system capacity. Further, according to Embodiment 1, designation upon selecting sub-carriers for which CQI fs are generated may be achieved simply by transmitting designation information designating a threshold value from the base station apparatus. It is therefore possible to reduce the amount of signal transmitted through the uplink without increasing the amount of signal transmitted through the downlink.

[0091]

(Embodiment 3)

FIG.7 is a block diagram showing a configuration of a wireless communication apparatus 700 according to Embodiment 3 of the present invention.

[0092]

As shown in FIG.7, wireless communication apparatus 700 of Embodiment 3 is of a configuration where encoding section 117, demodulating section 118, and SC selecting section 127 are removed, and threshold value determining section 701, used sub-carrier selecting section 702 and spreading section 703 are added in wireless communication apparatus 100 of Embodiment 1 shown in FIG.1. In FIG.7, portions with the same configuration as for FIG.1 are given the same numerals and are not described.

[0093]

CQI generating section 114 generates CQI's for each sub-carrier for all of the sub-

carriers using reception quality information inputted by reception quality measuring section 113. In other words, CQI generating section 114 has a reference table that stores information for CQI selection use to which different CQI's are allocated every predetermined region for measurement values indicating reception quality separated by threshold values for use in selection of the plurality of CQI's, and selects CQI's by referring to information for CQI selection use employing reception quality information inputted by reception quality measuring section 113. CQI generating section 114 outputs the generated CQI's to threshold value determining section 701. The CQI generating section is not limited to the case of generating CQI's for all sub-carriers, and CQI's may be generated after sub-carriers are selected by determining threshold values for reception quality for each sub-carrier.

[0094]

Threshold value determining section 701 as a selecting section selects only CQI's for which the reception quality is greater than or equal to a threshold value using CQI's, which are inputted by CQI generating section 114, and CQI threshold value information, which is inputted by decoding section 107, outputs the selected CQI's to encoding section 115, and outputs SC number information for the selected CQI's to used sub-carrier selecting section 702. As with the threshold value determining section 601 of Embodiment 2, threshold determining section 701 is capable of threshold value determination adopting either of a method of outputting eight levels of information indicating which of the eight levels, levels 1 to 8, the selected CQI's are at or a method of outputting relative value information.

[0095]

Used sub-carrier selecting section 702 selects sub-carriers, for which CQI's are generated using SC number information inputted by threshold value determining section 701, or sub-carriers, which have in advance a one-to-one correspondence with such sub-carriers, as transmission sub-carriers, and outputs CQI's to spreading section 703.

[0096]

Spreading section 703 subjects each CQI inputted by used sub-carrier selecting section 702 to spreading processing using CQI spreading code, allocates CQI signals to sub-carriers allocated by used sub-carrier selecting section 702 and outputs to multiplexer 122. The CQI spreading code is a spreading code that differs every wireless communication apparatus 700 of each user and the same spreading code is used for the sub-carriers and CQI's of all of wireless communication apparatus 700 of each user. The SC number information is not subjected to spreading processing by spreading section 703 because SC number information is not transmitted.

[0097]

Multiplexer 122 multiplexes CQI's inputted by spreading section 703 and NACK signals or ACK signals inputted by modulating section 121 and outputs to S/P converter 123. The multiplexed signal multiplexed at multiplexer 122 comes into a state where CQI of each sub-carrier is allocated to the sub-carrier itself, or where CQI' of each sub-carrier is allocated to a sub-carrier which has one to one correspondence with each sub-carrier. The details of the method for allocating sub-carriers will be described later.

[0098]

Next, a description is given using FIG.8 of a configuration for a base station apparatus of Embodiment 3. FIG.8 is a block diagram showing a configuration of a base station apparatus 800.

[0099]

As shown in FIG.8, a base station apparatus 800 according to Embodiment 3 is of a configuration where de-spreading section 801 and sub-carrier determining section 802 are added in base station apparatus 200 of embodiment 1 shown in FIG.2. In FIG.8, portions with the same configuration as for FIG.2 are given the same numerals and are not described.

[0100]

Transmission data processing sections 803-1 to 803-n are comprised of control information extraction section 205, demodulating section 206, decoding section 207, encoding section 209, transmission HARQ section 210, modulating section 211, encoding section 212, demodulating section 213, de-spreading section 801 and sub-carrier determining section 802. Transmission data processing sections 803-1 to 803-n are provided for the number of users and each of the transmission data processing sections 803-1 to 803-n carries out processing on transmission data for transmission to one user.

[0101]

De-spreading section 801 stores in advance a plurality of spreading codes used at wireless communication apparatus 700 of one user with which base station apparatus 800 is carrying out communication. De-spreading section 801 then subjects all of the sub-carriers inputted by control information extraction section 205 to de-spreading processing using the stored de-spreading code and outputs this to sub-carrier determining section 802. De-spreading sections 803 of each of transmission data processing sections 803-1 to 801-n stores in advance a different spreading code because a different spreading code is used at each wireless communication apparatus 700.

[0102]

Sub-carrier determining section 802 determines a sub-carrier, of which de-spreading output inputted by de-spreading section 801 is greater than or equal to a threshold value, to be a sub-carrier selected at wireless communication apparatus 700, and outputs SC number information of a sub-carrier with reception quality of greater than or equal to the threshold value to control section 208 and demodulating section 206. Because SC number information is not transmitted by wireless communication apparatus 700, sub-carrier determining section 802 stores in advance SC number information that is in common to wireless communication apparatus 700. Further, the reception quality is taken to be a relative value with respect to the pilot signal taking into consideration fluctuation in reception quality due to fading.

[0103]

Decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs CQI's for each of the designated number of sub-carriers included in the received signal to control section 208. Moreover, decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs a NACK signal or ACK signal included in the received signal to transmission HARQ section 210.

[0104]

Control section 208 carries out scheduling based on CQI's of wireless communication apparatus 700 for each user inputted by decoding section 207 and SC number information for wireless communication apparatus 700 of each user inputted by sub-carrier determining section 802, and MCS including M-ary numbers and encoding rates etc. are adaptively selected. In other words, control section 208 is capable of determining reception quality every sub-carrier for each wireless communication apparatus 700 using CQI's for each sub-carrier sent by wireless communication apparatus 700 of each user and SC number information for wireless communication apparatus 700 of each user inputted by sub-carrier determining section 802. MCS is then selected according to reception quality of each sub-carrier for each wireless communication apparatus 700. Control section 208 is capable of allocating data to be transmitted to each wireless communication apparatus 700 to sub-carriers of good reception quality at each wireless communication apparatus 700. Control section 208 has knowledge of the number of sub-carriers and it is possible to use and allocates transmission data to be sent to each wireless communication apparatus 700 within the range of usable sub-carriers to each sub-carrier. At this time, control section 208 carries out allocation, determining reception quality of a sub-carrier for which CQI's has not been transmitted by wireless communication apparatus 700 as being the poorest. Control section 208 outputs encoding rate information selected for each sub-carrier to encoding section 209, outputs modulation scheme information selected for each sub-carrier to modulating section 211 and outputs sub-carrier information allocated to each wireless

communication apparatus 700 using scheduling to a sub-carrier allocation section 215.

[0105]

Next, a description is given using FIG.3 and FIG.9 of a method for selecting CQI's occurring at wireless communication apparatus 700 for allocation to sub-carriers, and a format for a transmission signal when transmitting selected CQI's. It is possible to adopt two methods, a method where CQI' of each sub-carrier is allocated to the sub-carrier itself, or a method where CQI' of each sub-carrier is allocated to another sub-carrier with a one-to-one correspondence, as methods for allocating sub-carriers.

[0106]

First, a description is given of a method for allocating CQI's of each sub-carrier to the sub-carrier itself. In FIG.3, in the event that the reception quality of sub-carriers 11 to 21 and sub-carriers 34 to 41 is good from reception quality measurement results at the reception quality measuring sections 113-1 to 113-n, threshold value determining section 701 selects the CQI's of sub-carriers 11 to 21 and sub-carriers 34 to 41, used sub-carrier selecting section 702 allocates CQI's for sub-carriers 11 to 21 to sub-carriers 11 to 21, and the CQI's for sub-carriers 34 to 41 are allocated to the sub-carriers 34 to 41. On the other hand, threshold value determining section 701 does not select CQI's and SC number information for sub-carriers other than sub-carrier 11 to 21 and sub-carrier 34 to 41.

[0107]

Next, a description is given of a method for allocating CQI of each sub-carrier to another sub-carrier with a one-to-one correspondence. In FIG.3, in the event that the reception quality of sub-carriers 11 to 21 and sub-carriers 34 to 41 is good from reception quality measurement results at reception quality measuring sections 113-1 to 113-n, threshold value determining section 701 selects the CQI's of sub-carriers 11 to 21 and sub-carriers 34 to 41, used sub-carrier selecting section 702 allocates CQI's for sub-carriers 11 to 21 to sub-carriers 22 to 32 each having a one-to-one correspondence, and the CQI's of sub-carriers 34 to 41 are allocated to the sub-carriers 51 to 57 each having a one-to-one

correspondence. On the other hand, threshold value determining section 701 does not select CQI's and SC number information for sub-carriers other than sub-carrier 11 to 21 and sub-carrier 34 to 41. By storing sub-carriers having one-on-one correspondence with sub-carriers for which CQI's are generated at wireless communication apparatus 700 and base station apparatus 800 in advance, base station apparatus 800 can recognize which sub-carrier a received CQI is for.

[0108]

FIG.9 is a diagram showing a format for a signal transmitted from wireless communication apparatus 700 to base station apparatus 800. As shown in FIG.9, control information constituted of CQI's each having five bits and ACK signals or NACK signals for sub-carriers selected by a threshold value determination at threshold value determining section 701 is time division multiplexed and transmitted.

[0109]

According to Embodiment 3, sub-carriers satisfying reception quality of a threshold value or more designated by the base station apparatus are selected and CQI's are generated and transmitted for the selected sub-carriers. By reducing the signal volume transmitted through the uplink, it is possible to increase the data capacity that can be transmitted and reduce power consumption and by reducing interference with respect to other wireless communication apparatuses, it is possible to increase system capacity. Moreover, according to Embodiment 3, CQI's are allocated to selected sub-carriers with good reception quality and base station apparatus 800 is therefore capable of acquiring good quality CQI's. Further, according to Embodiment 3, CQI generated for each sub-carrier is allocated to the sub-carrier itself. Base station apparatus 800 can therefore determine which sub-carrier CQI is for even without transmitting SC number information and the volume of signal transmitted can therefore be reduced by the amount resulting from not sending the SC number information. Still further, in the event that the duplex scheme is TDD, the propagation path characteristics of the uplink and the downlink are substantially the same. It

is therefore possible to use sub-carriers with good reception quality for the downlink as those for the uplink also. In other words, it is possible to transmit a CQI signal using a superior propagation path.

[0110]

Further, according to Embodiment 3, designation upon selecting sub-carriers for which CQI fs are generated may be achieved simply by transmitting designation information designating a threshold value from the base station apparatus. It is therefore possible to reduce the amount of signal transmitted through the uplink without increasing the amount of signal transmitted through the downlink. According to Embodiment 3, the sub-carriers and CQI's are subjected to spreading processing using a spreading code specific to wireless communication apparatus 700 of each user. In the event that CQI's are transmitted for the same sub-carrier by the wireless communication apparatus 700 of a plurality of users, it is possible for base station apparatus 800 to discriminate which wireless communication apparatus 700 of which user a CQI has been sent from.

[0111]

(Embodiment 4)

FIG.10 is a block diagram showing a configuration for a wireless communication apparatus 1000 according to Embodiment 4 of the present invention.

[0112]

As shown in FIG.10, wireless communication apparatus 1000 of the fourth embodiment is of a configuration where CQI generating section 114, encoding section 115 and modulating section 116 are excluded in the wireless communication apparatus 100 of Embodiment 1 shown in FIG.1. In FIG.10, portions with the same configuration as for FIG.1 are given the same numerals and are not described.

[0113]

SC selecting section 127 selects a number of sub-carriers designated by the CQI quantity information in order of good reception quality using CQI quantity information

inputted by decoding section 107 and reception quality information inputted by the reception quality measuring sections 113-1 to 113-n. SC selecting section 127 then outputs the selected sub-carriers as SC number information to encoding section 117.

[0114]

Multiplexer 122 multiplexes SC number information inputted by the modulating section 118, and NACK signals or ACK signals inputted by modulating section 121 so as to generate transmission data and outputs the generated transmission data to S/P converter 123.

[0115]

Next, a description is given using FIG.11 of a configuration for a base station apparatus 1100 of Embodiment 4.

FIG.11 is a block diagram showing a configuration for base station apparatus 1100. In FIG.11, portions with the same configuration as for FIG.2 are given the same numerals and are not described.

[0116]

Decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs SC number information included in the received signal to control section 208. Moreover, decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs a NACK signal or ACK signal included in the received signal to transmission HARQ section 210.

[0117]

Control section 208 is able to be aware of sub-carriers of good reception quality at wireless communication apparatus 1000 of each user from SC number information for wireless communication apparatus 1000 of each user inputted by decoding section 207. Scheduling is therefore carried out based on a scheduling algorithm in such a manner that transmission data is allocated to sub-carriers of SC numbers with good reception quality. In other words, control section 208 carries out scheduling in such a manner that

transmission data is allocated in order from the top of the SC number because SC number is arranged in descending order of reception quality of sub-carriers. Control section 208 outputs sub-carrier information for use in transmission to sub-carrier allocation section 215.

[0118]

Encoding section 209 encodes transmission data at a fixed encoding rate set in advance and outputs to transmission HARQ section 210.

[0119]

Modulating section 211 modulates transmission data inputted by transmission HARQ section 210 using a fixed modulation method set in advance and outputs to multiplexer 214.

[0120]

Next, a description is given of a method for selecting CQI's at wireless communication apparatus 1000 and format for transmission signals during transmission of the selected CQI's, using FIG.3 and FIG.12.

[0121]

In FIG.3, in the event that the reception quality of sub-carriers 11 to 21 and sub-carriers 34 to 41 is good from the reception quality measurement results at reception quality measuring sections 113-1 to 113-n, SC selecting section 127 outputs SC number information only for sub-carriers 11 to 21 and sub-carriers 34 to 41. On the other hand, SC selecting section 127 does not output CQI's and SC number information for sub-carriers other than sub-carrier 11 to 21 and sub-carrier 34 to 41.

[0122]

FIG.12 is a diagram showing a format for a signal transmitted from wireless communication apparatus 1000 to base station apparatus 1100. As shown in FIG.12, control information outputted by multiplexer 122 is a signal of time-division-multiplexing of SC number information comprised of six bits for sub-carriers selected at SC selecting section 127 and a one-bit ACK/NACK signal.

[0123]

FIG.13 is a diagram showing a further example of a format for a signal transmitted from wireless communication apparatus 1000 to base station apparatus 1100. As shown in FIG.13, control information outputted by multiplexer 122 is signal of time-division-multiplexing of SC number information of 64-bits from the top for each of the 64 sub-carriers and a one-bit ACK/NACK signal. The SC number information is information time-division-multiplexed in order from the first sub-carrier of the 64 sub-carriers, with SC number information for sub-carriers that are selected being indicated as "1", and SC number information for sub-carriers that are not selected being indicated as "0". Therefore, bit 1, bits 2 to 10, bits 22 to 33 and bits 42 to 64 are indicated as "0", and bits 11 to 21 and bits 34 to 41 are indicated as "1".[0124]

According to Embodiment 4, a number of sub-carriers designated by a base station apparatus as having good reception quality are selected and SC number information is sent to the selected sub-carriers. The volume of signal transmitted through the uplink can therefore be reduced compared to the case where CQI's and SC number information are both transmitted. It is therefore possible to increase the data capacity that can be transmitted and reduce power consumption, and increase system capacity by reducing interference with respect to other wireless communication apparatuses. Further, according to Embodiment 4, designation while selecting sub-carriers for which CQI's are generated may be achieved simply by transmitting designation information designating the number of CQI's from the base station apparatus. It is therefore possible to reduce the amount of signal transmitted through the uplink without increasing the amount of signal transmitted through the downlink. Moreover, according to Embodiment 4, a base station apparatus is capable of carrying out encoding using encoding rates fixedly set in advance, modulation and suchlike. It is then possible to make circuits and apparatus smaller and reduce manufacturing costs by simplifying processing for encoding processing and modulation processing and so on.

[0125]

(Embodiment 5)

FIG.14 is a block diagram showing a configuration for a wireless communication apparatus 1400 according to Embodiment 5 of the present invention.

[0126]

As shown in FIG.14, wireless communication apparatus 1400 of Embodiment 5 is of a configuration where encoding section 115, modulating section 116, encoding section 117, demodulating section 118, and SC selecting section 127 are removed, and threshold value determining section 1401, CQI spreading code generating section 1402, used sub-carrier selecting section 1403 and spreading section 1404 are added in wireless communication apparatus 100 of Embodiment 1 shown in FIG.1 In FIG.7, portions with the same configuration as for FIG.1 are given the same numerals and are not described.

[0127]

Threshold value determining section 1401 as a selecting section selects only CQI's with reception quality greater than or equal to the threshold value using CQI's, which are reception quality information for selection use and inputted by CQI generating section 114, and CQI threshold value information, which is inputted by decoding section 107, outputs the selected CQI's to the CQI spreading code generating section 1402, and outputs SC number information for selected CQI's to the used sub-carrier selecting section 1403. As with the threshold value determining section 601 of Embodiment 2, threshold determining section 1401 is capable of threshold value determination adopting either of a method of outputting eight levels of information indicating which of the eight levels, levels 1 to 8, the selected CQI's are at or a method of outputting relative value information. This is not limited to selecting CQI's greater than or equal to a threshold value from CQI's for all of the sub-carriers, and it is also possible to select sub-carriers with reception quality greater than or equal to a threshold value before generating CQI's and only generating CQI's of the selected sub-carriers.

[0128]

CQI spreading code generating section 1402 constituting a spreading code selection section has a reference table that stores CQI spreading code information which is spreading code selection information for providing a relationship between associating CQI's and spreading codes. CQI spreading code generating section 1402 selects spreading codes by referring to CQI spreading code information using CQI's inputted by a threshold value determining section 1401 and outputs selected spreading code information to spreading section 1404. Spreading codes in the CQI spreading code information are codes that are different at wireless communication apparatus 1400 of each user and are codes that are different for each CQI.

[0129]

Used sub-carrier selecting section 1403 allocates an ACK signal or NACK signal as an error determination signal inputted by modulating section 121 to a sub-carrier selected using SC number information inputted by threshold value determining section 1401 and outputs to spreading section 1404. In the event that a plurality of SC number information are inputted from threshold value determining section 1401, used sub-carrier selecting section 1403 allocates ACK signals or NACK signals to a plurality of sub-carriers reported using the SC number information.

[0130]

Spreading section 1404 subjects sub-carriers allocated with ACK signals or NACK signals inputted by used sub-carrier selecting section 1403 to spreading processing using spreading codes inputted by the CQI spreading code generating section 1402 and outputs to multiplexer 122.

[0131]

Next, a description is given using FIG.15 of a configuration for a base station apparatus of Embodiment 5. FIG.15 is a block diagram showing a configuration for base station apparatus 1500.

[0132]

As shown in FIG.15, base station apparatus 1500 of Embodiment ,Tis of a configuration where a de-spreading section 1501 and a determining section 1502 are added in base station apparatus 200 of Embodiment 1 shown in FIG.2. In FIG.8, portions with the same configuration as for FIG.2 are given the same numerals and are not described.

[0133]

Transmission data processing sections 1503-1 to 1503-n are comprised of control information extraction section 205, demodulating section 206, decoding section 207, encoding section 209, transmission HARQ section 210, modulating section 211, encoding section 212, demodulating section 213, de-spreading section 1501 and determining section 1502. Transmission data processing sections 1503-1 to 1503-n are provided for the number of users and each of the transmission data processing sections 1503-1 to 1503-n carries out processing on transmission data for transmission to one user.

[0134]

De-spreading section 1501 stores in advance a plurality of spreading codes used at wireless communication apparatus 1400 of one user with which base station apparatus 1500 is carrying out communication. De-spreading section 1501 then subjects all of the sub-carriers inputted by control information extraction section 205 to de-spreading processing using the stored de-spreading code and outputs to determining section 1502. De-spreading sections 1501 of each of transmission data processing sections 1503-1 to 1503-n stores in advance a different spreading code because a different spreading code is used at each wireless communication apparatus 1400.

[0135]

Determining section 1502 has a reference table that stores CQI spreading code information for providing a relationship between the spreading code and CQI's, and stores spreading codes used by wireless communication apparatus 1400 of one user. Determining sections 1502 of each of transmission data processing sections 1503-1 to 1503-n stores in advance a different spreading code because a different spreading code is used at

each wireless communication apparatus 1400. CQI spreading code information is in common with CQI spreading code generating section 1402. Determining section 1502 obtains a de-spreading output for received signals inputted by de-spreading section 1501 every sub-carrier, and compares the largest de-spreading output with a threshold value (a third threshold value) every sub-carrier. Determining section 1502 determines sub-carriers whose largest de-spreading outputs are greater than or equal to the threshold value are sub-carriers selected by wireless communication apparatus 1400, selects CQI's of sub-carriers whose largest de-spreading outputs are greater than or equal to the threshold value by referring to CQI spreading code information using spreading codes employed in de-spreading of the largest de-spreading outputs, and outputs the selected CQI's to control section 208. At this time, the de-spreading output is expressed as a relative value with respect to the received signal power of a pilot, taking into consideration fluctuation in received signal power due to fading.

[0136]

Demodulating section 206 then de-modulates an ACK signal or NACK signal inputted by the determining section 1502 and outputs to decoding section 207.

[0137]

Decoding section 207 then outputs the results of demodulating the ACK signal or NACK signal inputted by demodulating section 206 to transmission HARQ section 210.

[0138]

Control section 208 carries out scheduling based on a scheduling algorithm using CQI's for wireless communication apparatus 1400 of each user inputted by determining section 1502, and adaptively selects MCS's for the M-ary numbers, encoding rates and suchlike. In other words, control section 208 is capable of determining reception quality every sub-carrier for each wireless communication apparatus 1400 using CQI's every sub-carrier inputted by determining section 1502. MCS's are then selected according to reception quality of each sub-carrier for each wireless communication apparatus 1400.

Control section 208 has knowledge of the number of sub-carriers and it is possible to use and allocates transmission data to be sent to each wireless communication apparatus 1400 within the range of usable sub-carriers to each sub-carrier. At this time, control section 208 carries out allocation, determining reception quality of a sub-carrier for which CQI's has not been transmitted by wireless communication apparatus 1502 as being the poorest. Control section 208 outputs encoding rate information selected for each sub-carrier to encoding section 209, outputs modulation scheme information selected for each sub-carrier to modulating section 211 and outputs sub-carrier information allocated to each wireless communication apparatus 1400 using scheduling to a sub-carrier allocation section 215.

[0139]

Next, a description is given using FIG.3 of a method for selecting sub-carriers at wireless communication apparatus 1400.

[0140]

Used sub-carrier selecting section 1403 allocates ACK signals or NACK signals to sub-carriers 11 to 21 and sub-carriers 34 to 41. Control information multiplexed at multiplexer 122 is a signal resulting from time-division-multiplexing of a plurality of ACK signals or NACK signals. In the case of FIG.3, a plurality of ACK signals or NACK signals are transmitted but as the ACK signals or NACK signals are one bit whereas the five bits are required for CQI's, the overall quantity of signal can be reduced.

[0141]

According to Embodiment 5, a sub-carrier of good reception quality is selected, and an ACK signal or NACK signal is allocated to the selected sub-carrier. By reducing the amount of signal transmitted on the uplink, it is possible to increase the data capacity that can be transmitted that can be transmitted and reduce power consumption, and, by reducing interference with respect to other wireless communication apparatuses, it is possible to increase system capacity. According to Embodiment 5, dual purpose use of the ACK signal or NACK signal indicative of whether or not re-transmission is required and

reception quality information which is CQI's is possible, and the CQI's and SC number information are not transmitted. The amount of signals transmitted through the uplink is therefore reduced to an extreme level. Further, according to Embodiment 5, designation while selecting sub-carriers for which CQI's are generated may be achieved simply by transmitting designation information designating the number of CQI's from the base station apparatus. It is therefore possible to reduce the amount of signal transmitted through the uplink without increasing the amount of signal transmitted through the downlink.

[0142]

In Embodiment 5, wireless communication apparatus 1400 spreads sub-carriers by selecting user-specific spreading codes and spreading sub-carriers allocated with ACK signals or NACK signals. However, this is by no means limiting, and it is also possible to perform scrambling by selecting user-specific scrambling codes and allocating ACK signals or NACK signals using the selected scrambling codes.

[0143]

In Embodiments 1 to 5, 64 sub-carriers are allocated within communication band F1 but this is by no means limiting and it is also possible to allocate an arbitrary number of sub-carriers other than 64. The wireless communication apparatus of Embodiments 1 to 5 may also be applied to a communication terminal apparatus. In Embodiments 3 to 5, sub-carriers to be selected are determined using a threshold determination for reception quality for each sub-carrier, but it is also possible to select just the number of sub-carriers notified by an upper order station as in Embodiment 1.

[0144]

[Industrial Applicability]

The wireless communication apparatus and reception quality reporting method of the present invention are capable of increasing data capacity that can be transmitted and reducing power consumption by reducing the amount of control signal transmitted, have an advantage of increasing system capacity by reducing interference with respect to other

wireless communication apparatuses, and suitable for use in giving reporting of reception quality for wireless communication apparatus.

[0145]

[Brief Description of Drawings]

FIG.1 is a block diagram showing a configuration of a wireless communication apparatus of Embodiment 1 of the present invention;

FIG.2 is a block diagram showing a configuration of a base station apparatus of Embodiment 1 of the present invention;

FIG.3 is a diagram showing an arrangement of sub-carriers on a frequency axis of Embodiment 1 of the present invention;

FIG.4 is a diagram showing a signal format of Embodiment 1 of the present invention;

FIG.5 is a diagram showing a signal format of Embodiment 1 of the present invention;

FIG.6 is a block diagram showing a configuration of a wireless communication apparatus of Embodiment 2 of the present invention;

FIG.7 is a block diagram showing a configuration of a wireless communication apparatus of Embodiment 3 of the present invention;

FIG.8 is a block diagram showing a configuration of a base station apparatus of Embodiment 3 of the present invention;

FIG.9 is a diagram showing a signal format of Embodiment 3 of the present invention;

FIG.10 is a block diagram showing a configuration of a wireless communication apparatus of Embodiment 4 of the present invention;

FIG.11 is a block diagram showing a configuration of a base station apparatus of Embodiment 4 of the present invention;

FIG.12 is a diagram showing a signal format of Embodiment 4 of the present

invention;

FIG.13 is a diagram showing a signal format of Embodiment 4 of the present invention;

FIG.14 is a block diagram showing a configuration of a wireless communication apparatus of Embodiment 5 of the present invention; and

FIG.15 is a block diagram showing a configuration of a base station apparatus of Embodiment 5 of the present invention.

[Description of the Symbols]

100 wireless communication apparatus

104 FFT section

105 control information extraction section

107, 111 decoding section

108 user data extraction section

110 reception HARQ section

112 pilot signal extraction section

113-1 to 113-n reception quality measuring section

114 CQI generating section

115, 117, 120 encoding section

116, 118, 121 modulating section

119 ACK/NACK generating section

122 multiplexer

124 IFFT section

127 SC selecting section

[NAME OF DOCUMENT] ABSTRACT

[Abstract]

[Object]

A wireless communication apparatus is capable of increasing data capacity that can be transmitted and reducing power consumption by reducing the amount of control signal to be transmitted, and capable of increasing system capacity by reducing interference with respect to other wireless communication apparatuses.

[Overcoming Means]

Control information extraction section 105 extracts CQI quantity designation information included in control information. Reception quality measuring sections (113-1 to 113-n) measure reception quality of each sub-carrier within a communication band. CQI generating section (114) generates CQI's for some of the sub-carriers of superior reception quality within the communication band. Multiplexer (122) multiplexes CQI's, sub-carrier number information generating the CQI's, and ACK signals or NACK signals. The SC selecting section (127) then selects the number of sub-carriers from a base station apparatus of superior reception quality allocated using the CQI quantity designation information.

[Selected Drawing] FIG.1

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FIG'S.1, 6, 7, 10, 14

102 RECEPTION WIRELESS PROCESSING SECTION

103 GI REMOVING SECTIONS

104 FFT SECTION

105 CONTROL INFORMATION EXTRACTION SECTION

106 DEMODULATING SECTION

107 DECODING SECTION

126 TRANSMISSION WIRELESS PROCESSING SECTION

108 USER DATA EXTRACTION SECTION

109 DEMODULATING SECTION

110 RECEPTION HARQ SECTION

111 DECODING SECTION

125 GI INSERTION SECTION

112 PILOT SIGNAL EXTRACTION SECTION

113-1~113-N RECEPTION QUALITY MEASURING SECTIONS

127 SC SELECTING SECTION

124 IFFT SECTION

123 S/P CONVERTER

122 MULTIPLEXER

116 MODULATING SECTION

115 ENCODING SECTION

114 CQI GENERATING SECTION

118 MODULATING SECTION

117 ENCODING SECTION

121 MODULATING SECTION

120 ENCODING SECTION

119 ACK/NACK GENERATING SECTION

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CONTROL INFORMATION

USER DATA

601 THRESHOLD VALUE DETERMINING CIRCUIT

701 THRESHOLD VALUE DETERMINING SECTION

702 USED SUB-CARRIER SELECTING SECTION

703 SPREADING SECTION

1401 THRESHOLD VALUE DETERMINING SECTION

1402 CQI SPREADING CODE GENERATING SECTION

1403 USED SUB-CARRIER SELECTING SECTION

1404 SPREADING SECTION

FIG'S.2, 8, 11, 15

202 RECEPTION WIRELESS PROCESSING SECTION

203 GI REMOVAL SECTION

204 FFT SECTION

205 CONTROL INFORMATION EXTRACTION SECTION 205

206 DEMODULATING SECTION

207 DECODING SECTION

208 CONTROL SECTION

209 ENCODING SECTION

210 TRANSMITTED SIGNAL HARQ SECTION

211 MODULATING SECTION

212 ENCODING SECTION

213 MODULATING SECTION

214 MULTIPLEXER

215 SUB-CARRIER ALLOCATION SECTION

216 S/P CONVERTER

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217 IFFT SECTION

218 GI INSERTION SECTION

219 TRANSMISSION WIRELESS PROCESSING SECTION

220 CONTROL DATA TRANSMISSION PROCESSING SECTION

CQI QUANTITY INFORMATION

CONTROL DATA

TRANSMISSION DATA

801 DE-SPREADING SECTION

802 SUB-CARRIER DETERMINING SECTION

1501 DE-SPREADING SECTION

1502 DETERMINING SECTION

FIG.3

FREQUENCY

FIG'S.4, 12

6 BITS, 5 BITS, 1 BIT

SC NUMBER INFORMATION 11, CQI FOR SC NUMBER INFORMATION 11 . . . . .

CONTROL INFORMATION

FIG.5

1 BIT, 11 BITS . . .

CQI FOR SC NUMBER 11, . . .

BIT 1, BIT 10, BIT 21 . . .

CONTROL INFORMATION

FIG.9

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5 BITS, 1 BIT

CQI FOR SC(B)

ACK/NACK SIGNAL

CONTROL INFORMATION

FIG.13

64 BITS, 1 BIT

1 BIT, 2 BITS, . . .

CONTROL INFORMATION